PHYTOTOXICOLOGY SECTION INVESTIGATION IN THE VICINITY OF JOHNSON CONTROLS INC., BATTERY GROUP (FORMERLY VARTA BATTERY LTD.) ST. THOMAS - 1990

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IN THE VICINITY OF JOHNSON CONTROLS INC., BATTERY GROUP

(FORMERLY VARTA BATTERY LTD.)

ST. THOMAS - 1990

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Background

Johnson Controls Inc., Battery Group (formerly Varta Battery Ltd.) began operation in St. Thomas in 1981. A pre-operational Phytotoxicology Section vegetation assessment survey was conducted in 1980. Vegetation surveys have been conducted every year since 1980, except for 1981 and 1988 (1,2,3,4,5,6 and 7). Soil surveys were conducted in 1980, 1981 and 1982 (see Appendix A for a summary of survey activities).

The company is located on the northeast outskirts of St. Thomas in an industrial park that is only partially developed. Some of the land is still being farmed. There are some residences in the immediate area. Johnson Controls Inc., Battery Group is primarily a source of lead emissions, although smaller amounts of antimony are emitted. Elevated concentrations of lead and antimony have been detected in vegetation in the immediate vicinity of the plant.

Because of the lack of suitable species of vegetation for sampling in the immediate vicinity of the company, an annual moss bag survey was established in 1984 to better delineate the pattern of atmospheric deposition (8). These moss bag surveys have shown a pattern of accumulation of lead and antimony downwind from the company to a distance of approximately half a kilometer.

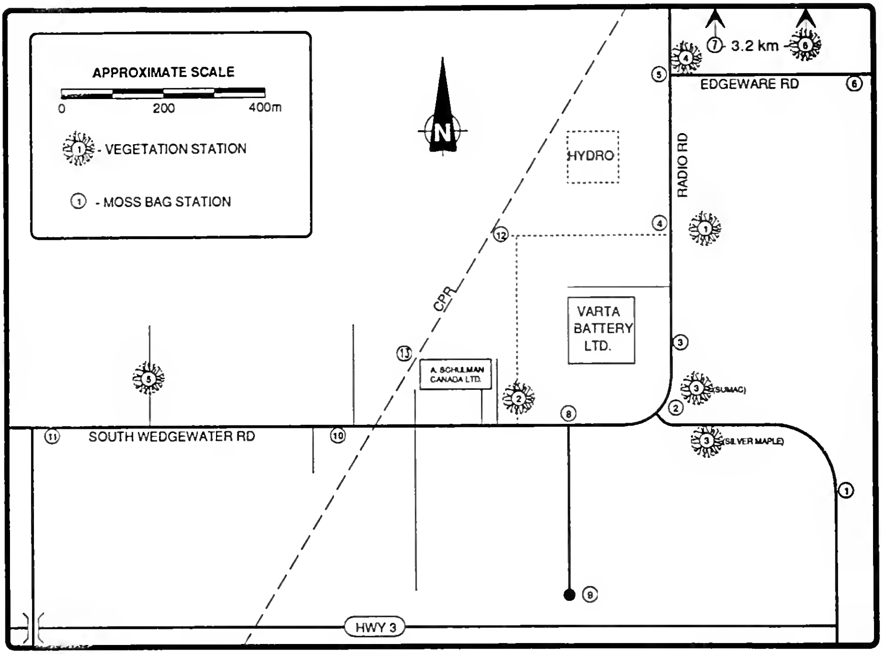
The concentrations of lead and antimony in vegetation and moss bags have been gradually increasing since the survey started. The highest levels were reached in 1986. In the late summer of 1986 the company had reported to the regional MOE office that a potential source of the emissions had been found and abatement action was taken to correct the problem. The results of the 1987 survey showed a significant decrease in the lead levels in both vegetation and moss bags (1). The antimony levels did not show a corresponding decrease in 1987. Nineteen eighty nine was the first year since 1982 in which the concentrations of lead and antimony in tree foliage did not exceeded the Phytotoxicology Section's Upper Limit of Normal guidelines for tree foliage, at sample stations close to the source.

Methods

On May 30, 1990 Mr. R.D. Jones of the Phytotoxicology Section established a 13 station moss bag survey in the vicinity of Johnson Controls Inc., Battery Group, St. Thomas (see Figure 1). All of the moss bag stations were in the same locations as the previous moss bag surveys. The moss bags were changed monthly, on June 29, and July 30. The moss bags at Station 11 were lost for the first two months due to the hydro pole supporting the bag being removed during road construction. The last moss bags were collected on August 30, at which time duplicate tree foliage samples were collected at six locations around Johnson Controls Inc., Battery Group (see Figure 1). The foliage was collected from the same trees as in the 1987 survey. The samples where collected using standard Phytotoxicology sampling techniques (9).

All samples were delivered to the Phytotoxicology Section sample processing laboratory in Toronto where they were dried and ground before being submitted to the Inorganic Trace Contaminants Section, Laboratory Services Branch for chemical analysis. All of the moss bags from the three monthly collections were submitted as one submission at the same time as the vegetation samples. The samples were analyzed for lead, antimony, zinc, cadmium, copper, nickel, cobalt and aluminum.

Figure 1: Sketch Map Showing the Approximate Locations of the Vegetation and Moss Bag Sampling Stations in the Vicinity of Johnson Controls Inc., Battery Group, St. Thomas, 1990



Results

The results of the analysis of lead, antimony, cadmium and zinc in tree foliage are given in Table 1. The results for the analysis of copper, nickel, cobalt and aluminum in tree foliage are given in Table 2. All of the reported tree foliage results are the mean of duplicate samples.

The results of the analysis of lead, antimony, cadmium and zinc in moss bags are given in Table 3. The results for the analysis of copper, nickel, cobalt and aluminum in moss bags are given in Table 4.

All results are expressed as µg/g on a dry weight basis. Phytotoxicology "Upper Limit of Normal" (ULN) Rural guidelines for each element are reported at the bottom of each table. Where results exceed the ULN guidelines the results are shown in bold underlined type face.

Table 1: Results of Chemical Analysis for Lead, Antimony, Cadmium and Zinc in Tree Foliage Collected in the Vicinity of Johnson Controls Inc., St. Thomas, August 30, 1990

Station Number	Species	Lead µg/g	Antimony µg/g	Cadmium µg/g	Zinc µg/g
1	white oak	8.1	0.43	0.22	18
	silver maple	5.6	0.73	0.16	33
2	Manitoba maple	13	0.51	0.25	14
3	silver maple	4.8	0.52	0.17	40
	sumac	16	1.6	0.15	15
4	silver maple	4.2	<0.20	0.25	31
5[a]	silver maple	1.1	<0.20	0.21	25
6[b]	white oak	0.9	<0.20	0.3	14
	silver maple	0.8	<0.20	0.18	26
	sumac	0.9	<0.20	<0.10	15
Rural ULN		30	3	1.0	250

[a] - Urban control station. [b] - Rural control station.

Table 2: Results of Chemical Analysis for Copper, Nickel, Cobalt and Aluminum in Tree Foliage Collected in the Vicinity of Johnson Controls Inc., St. Thomas, August 30, 1990

Station Number	Species	Copper µg/g	Nickel µg/g	Cobalt µg/g	Aluminum µg/g
1	white oak	5.6	1.1	0.2	48
	silver maple	5.5	1.9	0.5	59
2	Manitoba maple	4.0	1.7	<0.2	74
3	silver maple	8.3	1.3	<0.2	46
	sumac	4.3	1.3	<0.2	136
4	silver maple	8.0	1.5	<0.2	119
5[a]	silver maple	6.6	1.7	<0.2	95
6[b]	white oak	6.2	1.1	0.3	46
	silver maple	5.6	0.8	0.4	45
	sumac	6.6	<0.5	<0.2	31
Rural ULN		20	5	2	500

[a] - Urban control station. [b] - Rural control station.

Table 3: Results of Chemical Analysis for Lead, Antimony, Cadmium and Zinc in Moss Bags in the Vicinity of Johnson Controls Inc., Battery Group, St. Thomas, June, July and August, 1990

Station Number	Lead June	Lead July	Lead August	Antimony June	Antimony July	Antimony August	Cadmium June	Cadmium July	Cadmium August	Zinc June	Zinc July	Zinc August
	Chemical Analysis Results by Element and Month (µg/g dry weight)											
1	27	27	38	0.45	0.26	0.37	0.34	0.54	0.46	99	73	68
2	41	50	59	1.3	0.56	0.69	0.44	0.62	0.48	**220**	**240**	**200**
3	43	45	52	1.5	0.94	0.92	0.46	0.68	0.44	**160**	**130**	**130**
4	45	45	49	<0.2	0.41	0.86	0.34	0.72	0.54	**450**	**440**	**260**
5	39	39	46	1.0	0.42	0.46	0.4	0.72	0.48	**150**	79	72
6	30	30	42	0.35	0.42	0.38	0.34	0.40	0.46	90	81	71
7[b]	20	31	41	<0.2	0.50	0.31	0.34	0.38	0.40	58	39	41
8	23	50	48	<0.2	0.50	0.56	0.50	0.54	0.54	70	63	76
9	27	44	44	0.27	0.43	0.40	0.42	0.82	0.76	**130**	**110**	**420**
10	22	42	46	<0.2	0.43	0.41	0.22	0.64	0.78	96	73	86
11	-	-	44	-	-	0.32		-	0.36	-	-	52
12	20	43	42	<0.2	0.44	0.41	0.82	1.3	0.88	90	**120**	**120**
13	16	35	40	<0.2	0.36	0.24	0.54	0.82	0.88	62	75	52
Rural ULN		35			a			2			100	

a - Not enough data to determine upper limit of normal for antimony in moss bags in rural locations

[b] - control station.

Table 4: Results of Chemical Analysis for Copper, Nickel, Cobalt and Aluminum in Moss Bags in the Vicinity of Johnson Controls Inc., Battery Group, St. Thomas, June, July and August, 1990

Station Number	Copper June	Copper July	Copper August	Nickel June	Nickel July	Nickel August	Cobalt June	Cobalt July	Cobalt August	Aluminum June	Aluminum July	Aluminum August
	Chemical Analysis Results by Element and Month (µg/g dry weight)											
1	5.8	6.2	5.2	4.0	3.9	4.1	1.5	0.9	0.7	730	920	970
2	8.5	9.1	11	5.2	7.5	3.6	1.7	1.1	0.6	950	990	820
3	6.7	8.4	5.0	5.1	5.7	13	1.4	1.1	0.6	880	1100	850
4	22	17	20	7.2	8.3	9.0	0.9	0.9	0.6	740	700	900
5	9.1	5.3	5.4	6.3	5.1	3.8	0.9	0.7	0.6	920	960	940
6	6.6	6.1	4.6	7.3	19	4.1	1.1	0.7	0.6	830	900	820
7[b]	5.6	5.1	5.2	5.1	3.4	3.9	1.1	0.6	0.4	590	710	900
8	6.8	6.0	5.2	6.0	5.3	4.5	1.1	0.7	0.8	850	760	880
9	8.2	7.1	5.1	12	8.9	4.3	1.2	1.0	0.5	960	960	940
10	5.9	5.4	4.8	4.6	4.4	4.5	0.9	0.8	0.6	1100	900	810
11	-	-	5.5	-	-	5.4	-	-	0.4	-	-	850
12	5.4	5.5	5.6	4.4	4.0	4.2	1.1	0.7	0.9	730	1000	940
13	5.5	6.1	5.5	4.3	4.7	4.9	1.1	0.7	0.7	730	1200	1000
Rural ULN		8			6			a			1700	

a - Not enough data to determine upper limit of normal for cobalt in moss bags in rural locations

[b] - control station.

Discussion

Lead and antimony levels in tree foliage were lower in 1990 compared to 1988 and 1989. The levels of lead and antimony in tree foliage at the four stations closest to the company were at or below the 1980 pre-operational levels (see Figures 2 and 3). While declines in lead levels in tree foliage had been observed in 1988 and 1989, this is the first time there has been a significant decline in antimony levels since the plant started operation. The lead and antimony levels were still higher than the two control stations indicating that the plant is still a minor source of lead and antimony emissions.

Figure 2: Average Lead Levels in Maple Foliage for Stations 1, 2, 3 and 4

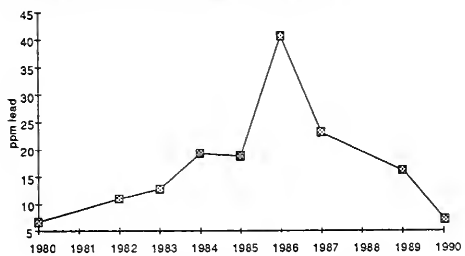
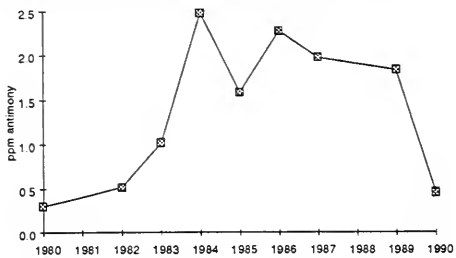


Figure 3 Average Antimony Levels in Maple Foliage for Stations 1, 2, 3 and 4



The levels of cadmium, zinc, copper, nickel cobalt and aluminum in tree foliage were all low and showed no pattern of decreasing concentration with increasing distance from the plant. The results for these elements were similar to previous years. This was the first year in which there were no exceedences of the Upper Limit of Normal in tree foliage for any of the parameters tested.

Lead levels in moss bags in 1990 were similar to previous years. However, the pattern of decreasing concentration with increasing distance was not as strong as in previous years. There were significant differences from month to month. On average, the June levels were the lowest and the August levels were the highest. While there were a significant number of exceedences of the Rural Upper Limit of Normal for lead in moss bags, especially in August, the range of values was very small. The difference between the highest level and lowest were, on average, only a factor of two.

Antimony levels in moss bags were significantly lower in 1990 compared to 1989. Antimony concentrations in moss bags in 1989 ranged as high as 6.9 ppm, while in 1990 the highest level was 1.5 ppm.

As in 1987 and 1989, there were a number of exceedences of the Rural ULN guidelines for zinc in moss bags in 1990. The 1990 levels were similar to the 1989 results. There was a similar pattern for copper and nickel. These elevated values of zinc, copper and nickel are not seen in the vegetation. With the exception of the exceedences of the ULNs at Station 9, all of the elevated levels of these metals were located immediately east of the company. This pattern was not observed in vegetation.

Summary

The levels of lead and antimony in vegetation in the vicinity of Johnson Controls Inc., Battery Group, St. Thomas declined in 1990 compared to 1989. The decline in lead levels follows the trends observed in the past couple of years, and levels are now down to preoperational levels. The decline in antimony levels was the first significant decline observed since the company started operations. The decline in antimony was also observed in moss bags. The levels of lead in moss bags were similar to those of previous years. However the range of lead levels between the controls and the close in stations was not as great as in previous years. The pattern of decreasing lead concentration in moss bags with increasing distance was also not as distinct as in 1987 and 1989.

As in previous years, there were numerous exceedence of the ULNs for copper, nickel and zinc in moss bags near the company but corresponding levels were not observed in vegetation.

Appendices

Appendix A Summary of Survey Activities

Table 4: Number of Stations Sampled for Soil, Vegetation and Moss Bags from 1980 to 1987.			
Year	Soil	Vegetation	Moss Bags
1980	6	6	
1981	6		
1982	6	6	
1983		6	
1984		6	12
1985		6	13
1986		6	13
1987	6	6	13
1989		6	13
1990		6	13

Appendix B References

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9. Ontario Ministry of the Environment, 1983. Field Investigation Manual. Phytotoxicology Section - Air Resources Branch; Technical Support Sections - NE and NW Regions
10. Ontario Ministry of the Environment, 1989. Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples. Phytotoxicology Section - Air Resources Branch ARB-138-88-Phyto. ISBN: 0-7729-5143-8

Appendix C Derivation and Significance of MOE "Upper Limits of Normal" Contaminant Guidelines

The MOE "upper limits of normal" contaminant guidelines essentially represent the expected maximum concentration of contaminants in surface soil (non-agricultural), foliage (tree and shrub), grass, moss bags and or snow from areas of Ontario not subject to the influence of point sources of emissions. "Urban" guidelines are based upon samples collected from centers of minimum 10,000 population. "Rural" guidelines are based upon samples collected from non-built-up areas. Samples were collected by MOE personnel using standard sampling techniques (ref: Ministry of the Environment, 1983. Field Investigation Manual. Phytotoxicology Section - Air Resources Branch: Technical Support Sections - NE and NW Regions). Chemical analyses were performed by the MOE Laboratory Services Branch.

The guidelines were calculated by taking the arithmetic mean of available analytical data and adding three standard deviations of the mean. For those distributions that are "normal", 99% of all contaminant levels in samples from "background" locations (i.e. not affected by point sources nor agricultural activities) will lie below these upper limits of normal. For those distributions that are non-normal, the calculated upper limits of normal will not actually equal the 99th percentile, but nevertheless they lie within the observed upper range of MOE results for Ontario samples.

Due to the large variability in element concentrations which may be present across Ontario, even in background data, control samples should always be collected. This is particularly important for soils, which may show large regional variations in element composition due to difference in parent material. Species of vegetation which naturally accumulate high levels of an element also may be encountered.

It is stressed that these guidelines do not represent maximum desirable or allowable levels of contaminants. Rather, they serve as levels which, if exceeded, would prompt further investigation on a case by case basis to determine the significance, if any, of the above normal concentration(s). Concentrations which exceed the guidelines are not necessarily toxic to plants, animals or man. Concentrations which are below the guidelines are not known to be toxic.